

SCIENCE

FRIDAY, MAY 11, 1888.

THE GRAVE APPREHENSIONS as to the fate of Stanley's expedition, that are occasionally published in the daily papers, have no other foundation than the lack of any news since Stanley's departure from the mouth of the Aruvimi. We know from Junker's descriptions, that the region he has to pass through is a very difficult one, and that his original estimates of the time required to reach the Mvutan Nsige from the Kongo were too low. If any serious mishap should have occurred to him, exaggerated rumors would undoubtedly have reached the coast; for even in Africa a caravan of hundreds of men, including several white men, does not disappear never to be heard of again. News did not reach the lower Kongo, as no steamer has been able to visit Stanley Falls and the mouth of the Aruvimi since Stanley's departure. It is somewhat difficult to understand the reason for this state of affairs, except it may be that the steamers have suffered from their long-continued service, or are needed for the actual use of the stations near Leopoldville. The steamers of the missions and of the Sandford Exploring Expedition are not at the disposal of the Free State. The 'En Avant' has just returned from her great expedition up the Welle, and thus the number of available steamers was practically very small. Recent papers inform us that a new steamer, the 'Roi des Belges,' was launched on Stanley Pool Feb. 18, while the 'Ville de Bruxelles' is being transported to the upper Kongo. It is to be hoped that communication with the upper Kongo, which has practically been interrupted since the capture of Stanley Falls Station by the Arabs, — except when Stanley and Tippo-Tip ascended the Kongo, — will be resumed ere long.

WILLIAM C. WYCKOFF, late editor of the *American Magazine*, who died in Brooklyn last week, was well known among the scientific men of the United States. A few years ago, when the *New York Tribune* devoted much more space to scientific matters than now, Mr. Wyckoff, then a member of its editorial staff, reported the annual meetings of the American Association for the Advancement of Science; and it is doing him only justice to say that no equally good reports have ever been made for a daily newspaper, rarely if ever for a weekly or monthly journal devoted to science. He was singularly careful and painstaking as a reporter, and his work received wide recognition among those most interested in and best able to judge of it. The same conscientiousness characterized all of his work as a writer and editor. His service upon the *Tribune* extended through many years. More recently, as secretary of the Silk Association of America, he has published a number of very valuable volumes in relation to that industry. His latest work was upon the *American Magazine*, as its editor, which in one year he built up from the old *Brooklyn Magazine*. This work speaks for itself. Mr. Wyckoff had a very wide circle of acquaintances and friends in the journalistic profession.

THE PROJECT of having a refuge-hut high up on the main range of the White Mountains — one which should afford adequate shelter in any weather — has long been entertained by members of the Appalachian Mountain Club, and the council of the society believe that the time has come for an effort in this direction. It is their desire to build this summer a permanent stone cabin at Madison Spring, in the saddle between Mount Adams and Mount Madison, provided with sleeping-bunks, a stove, and the most necessary fur-

niture. Cooking-utensils and axe would be kept there, and there is a good supply of fuel at hand. The structure will be useful in two ways: first, as a resting-point for persons who wish to visit the Northern Peaks, or to traverse the ridge to or from Mount Washington, but who have not the strength to accomplish these expeditions (distinctly the most interesting in the White Mountains) in a single day; second, as a comfortable camping-place for scientists, photographers, and lovers of scenery, who will be able to make prolonged stays in this interesting upper region, and be independent of the weather. The structure which the council have in mind will cost (at that altitude) from five hundred to seven hundred and fifty dollars, if built in a thorough manner. Until five hundred dollars are secured, it will hardly be prudent to begin the work. The council have appropriated one hundred and fifty dollars from the yearly income, and some subscriptions can probably be obtained outside; but at least three hundred dollars ought to be made up by subscriptions inside the club. The council make, therefore, an earnest appeal to all persons interested in this enterprise to indicate at once the sums they are willing to contribute. Assistance from any one interested will be gladly received. Subscriptions should be sent to the councillor of improvements, Frederic D. Allen, 10 Homboldt Street, Cambridge, Mass.

DR. EMIL BESSELS.

IN a recent number of *Science* we announced the death of Dr. Emil Bessels, who won so much well-deserved renown on the 'Polaris' expedition. The deceased was born in 1847 at Heidelberg. At an early age he left school and entered business, but his love of science prompted him to resume his studies. He became a student at the University of Heidelberg, and paid particular attention to zoölogy. His first publication of importance was on the distribution of the American deer. In 1869, at the instance of the late Dr. A. Petermann, he joined the first German polar expedition, which, although unsuccessful in its attempts to reach Gillis Land, made important discoveries in those parts of the Arctic Ocean lying between Spitzbergen and Nova Zembla. Particular attention was paid to observations on the temperature and salinity of the ocean. His work on this expedition had proved him to be an energetic worker and excellent observer; and when the American polar expedition was organized, in 1870, he was invited to join it as scientist. The progress and the events of this expedition are so well known that it is unnecessary to dwell upon them. It ought to be stated, however, that the scientific results are almost solely the work of the deceased. Setting aside the valuable geographical discoveries which Bessels made on excursions by sledge, and among which the exploration of Petermann Fiord ranks highest, his hydrographical and meteorological observations are of great importance. He was the first to give the explanation of foehn-like winds now universally adopted; he was the first to pronounce the insularity of Greenland, founding his conclusion upon the fact that the Atlantic tide entered the northern part of Robeson Channel. It will be remembered that his conclusions were fully corroborated by the discoveries of the Nares and Greely expeditions. After his return from the Arctic, he was engaged in working up the results of the expedition; but he had hardly finished this task, when he began to make preparations for a new expedition, the prime object of which was to be physical observations. He corresponded about his plans with Weyprecht and Dorst, and preparations were made; but, when all was ready, unfortunate events prevented the carrying-out of the plan, which would doubtlessly have resulted in great additions to our knowledge of the polar regions. During the last years of his life he resided in Washington, engaged in completing a work on physical geography

and an anthropological work on the Eskimo, both of which he left unfinished. Besides this, he wrote a popular account of Eskimo life, which it is hoped will be published at an early date. When the first expeditions to the rescue of Greely were prepared, he strongly advocated that a well-equipped expedition be sent out at once. During this period he wrote his valuable contributions to the history of the American polar expeditions. He died while on a visit to his friends in Germany. His amiability will be remembered by all his friends. His valuable contributions to science will make scientists regret that he was not allowed to complete the numerous works he had begun, which would have secured to him one of the most prominent places among modern scientists.

THE COURSE OF HUMAN PROGRESS.¹

THE course of human events is not an eternal round. In the wisdom of the ancients there are many proverbs to the effect that that which is, has been before and will be again. So far as human experience extends, unaided by reason, days and nights come and go, winter follows summer, and summer follows winter, and all the phenomena of nature seem to constitute an endless succession of recurrent events. But there is a higher knowledge which observes a progress by steps so minute that it was left to modern science to discover it. In the history of humanity the changes which result in progress are more readily perceived; and the aphorism of the ancients, that "there is nothing new under the sun," is but a proverb of ignorance.

Every child is born destitute of things possessed in manhood which distinguish him from the lower animals. Of all industries he is artless, of all institutions he is lawless, of all languages he is speechless, of all philosophies he is opinionless, of all reasoning he is thoughtless; but arts, institutions, languages, opinions, and mentations he acquires as the years go by. In all of these respects the new-born babe is hardly the peer of the new-born beast; but, as the years pass, ever and ever he exhibits his superiority in all of the great classes of activities, until the distance by which he is separated from infancy is so great that he seems to live in another realm. These activities that separate the man from the babe are the humanities. In like manner the human race has been segregated from the tribes of beasts by the gradual acquisition of these humanities, by the invention of arts, the establishment of institutions, the growth of languages, the formation of opinions, and the evolution of reason.

The road by which man has travelled away from purely animal life is very long; but this long way has its landmarks, so that it can be divided into parts. There are stages of human culture, and they have been denominated savagery, barbarism, and civilization.

All the grand classes of human activity are inter-related in such manner that one presupposes another, and no one can exist without all of the others. Arts are impossible without institutions, languages, opinions, and reasoning; and in like manner every one is developed by aid of the others. If, then, all of the grand classes of human activities are interdependent, any great change in one must effect corresponding change in the others. The five classes of activities must progress together. Art-stages must have corresponding institutional, linguistic, philosophic, and psychic stages.

Stages of progress common to all the five grand classes of human activities may properly be denominated culture-stages, and such culture-stages should be defined by characterizing all these activities in each stage. This I shall attempt to do, but in a brief way. [The lecturer then described savagery with regard to its arts, institutions, language, philosophy, and mind, and summed up his description in the following way.]

The savage has invented rude arts by which he obtains food, clothing, and shelter. He has invented a rude system of kinship society, with descent in the female line. He has spoken language, gesture-speech, and picture-writing, but is without hieroglyphic, syllabic, or alphabetic writing. He has a philosophy which informs conspicuous and important inanimate objects with spirit-life, and which deifies the brute; and a mind whose perceptions are so

slightly developed that conventional characters do not convey ideas, and his arithmetic is yet counting. Such, in general, are the characteristics of all savage people that have been carefully studied by anthropologists.

How was this savagery transformed into barbarism, and what is that barbarism? [The lecturer began his answer to these questions by considering the change in arts.] There are two arts, intimately associated, the invention of which causes a radical change in all the departments of humanity; viz., agriculture and the domestication of animals. Agriculture began in savagery. Many savage tribes cultivate little patches of ground, and thereby provide themselves with a part of their subsistence. This petty agriculture does not of itself result in any radical change; but when the art has developed to such an extent that the people obtain their chief subsistence therefrom, and especially when it is connected to the domestication of animals, so that these are reared for food and used as beasts of burden, the change for which we seek is wrought. It seems that extensive agriculture was first practised in arid lands by means of artificial irrigation. In more humid lands the supply is more abundant and the incentive to agriculture is less. On the other hand, agriculture is more difficult in humid lands than in arid lands. The savage is provided with rude tools, and with them he can more easily train water upon desert soils than he can repress the growth of valueless plants as they compete for life with those which furnish food. The desert soil has no sod to be destroyed, no *chaparral* to be eradicated, no trees to be cut down with their great stumps to be extracted from the earth. The soil is ready for the seed. Throw upon that soil a handful of seed, and then sprinkle it with a few calabashes of water once or twice through the season, and the crop is raised; or train upon a larger garden-patch the water of a stream, and let it flood the surface once or twice a year, and a harvest may be reaped.

Petty agriculture, such as I have described as belonging properly to savagery, has been widely practised in the four quarters of the globe among savage people, quite as much in humid as in arid regions; but the art seems not to have indigenously extended beyond that stage in any but arid regions. The earliest real agriculture known to man was in the valley of the Nile, an almost rainless land, but the floods of the Nile were used to fertilize the soil; again, in the land of Babylon, along the Tigris and the Euphrates, extensive agriculture grew up, but it was dependent upon artificial irrigation; still farther to the south-east, in the Punjab, another system of indigenous agriculture was developed by utilizing the waters of the five great rivers; still farther to the east an indigenous agriculture was developed on an extensive scale, all dependent upon artificial irrigation, as the Chinese use the waters of the Hoang-ho and the Yang-tse-kiang; in South America the first system of agriculture was developed in Peru, all dependent upon artificial irrigation; and, finally, to the north of the Isthmus of Panama, in Central America and Mexico, agricultural art was highly developed, and here also they were dependent upon artificial irrigation. From these six examples of high agricultural art, all the agriculture of the world has been developed; from these centres it has spread. The petty agriculture of humid lands never went beyond the utilization of little patches of ground in the forest glades, until it was borrowed in a higher state from arid lands. Everywhere with the development of agriculture in the arid lands the art of domesticating animals was associated, and everywhere such animals were raised for food, and to a large extent they were used as beasts of burden.

[The lecturer, in continuation, showed how changes in the arts wrought changes in institutions, changes in language, changes in philosophy, and psychic changes during the transition period from savagery to barbarism, and summed up this portion of his discourse as follows.]

From the foregoing brief characterization it will be seen that barbaric culture implies a somewhat high state of agriculture and the domestication of animals, one or both; it implies that patriarchal institutions have been organized, that descent is in the male line, that ranks in society have been established, and that new laws regulating property have been enacted; it implies that the people use hieroglyphs; it implies that domestic worship is ancestral worship, that tribal worship is based on phsytheism, and that the phenomena of the universe are attributed to nature-gods; and, finally,

¹ Lecture delivered May 5, by Major J. W. Powell, in the course of free lectures under the auspices of the Philosophical, Biological, and Anthropological Societies of Washington.

it implies that men can perceive meanings in conventional signs, and that arithmetic has been invented.

[The change from barbarism into civilization was next described.] In barbarism there are tools, but no machinery; metallurgical processes are yet undiscovered; the use and reduction of iron are unknown. The employment of the latter led to an important advance in naval architecture; to the accumulation of wealth in the products of the soil, in woven fabrics, in iron and copper and silver and gold; and these together to the establishment of a system of exchanges through fleets and caravans; and thus commerce was developed.

In barbarism the people lived largely in towns, each town being an independent body politic. But when commerce was developed, towns grew into cities, and with increasing wealth there was increasing temptation to predatory forays; and at the same time the discovery of bronze and copper had given the barbaric warriors superior arms. Then it became necessary to defend the cities with their wealth and teeming population, and they were walled. At this stage the people have learned to burn brick and to cut stone, and a vast improvement in architecture is the result. They have also become skilful in the manufacture and decoration of pottery; there are forges in the cities, and glass-manufactories flourish. Water-mills are set up, great irrigating ditches are built, and mines are opened.

It is not proposed to set forth the great industrial achievements of modern civilization by which the powers of nature have been discovered and utilized by mankind: it is simply intended to explain the first form of civilization, that it may be distinguished from anterior barbarism.

[Major Powell next treated of the change in institutions which marked the transition from barbarism to civilization.]

In setting forth the evolution of barbarism into civilization it becomes necessary to confine the exposition to eastern Europe, western Asia, and northern Africa, and to a large extent to one great stock of people,—the Aryan race,—together with those other stocks—as the Egyptian, the Semitic, and the Turanian races—whose history is involved in that of the Aryan, and with whom they were inextricably mixed, and whose ultimate destiny was controlled by the progress of Aryan culture. On the other hand, some Aryan people are not included, from the fact that they severed themselves from the body of the people and entered upon an independent history. The centre of this world was the Mediterranean Sea; and from its shores, far away in every direction, the peoples were scattered whose history was involved in one vast interdependent system, for the culture of every one re-acted upon the culture of every other one. Throughout all the region above indicated, tribal towns and nomadic villages existed. Gradually the most prosperous towns became centres of power and population. Less powerful tribes became subject to and dependent upon more powerful tribes, and gradually many tribal towns became city States, and these city States were transitional bodies politic between barbarism and civilization.

[The organization of a city State was then described, and the origin of ranks shown. The organization of city States into nations was then traced out, the nations being essentially tax-gathering bodies, with no attempt to re-organize the society of such nations so as to secure general homogeneity and interdependence of parts, and that unification which gives solidarity. This came later. The evolution of kingship, the contest between the throne and the Council or Parliament, the origin of courts, the development of civilized law, and the establishment of the authority of the superior in rank, were next explained. Thus it was shown that the institutional change from barbarism to civilization was a change first in the constitution of the State itself, a change in the form of government, a change in the principles of law. In like manner the change in language, the change in opinion, and the change in mentations was traced. Under the last head Major Powell spoke as follows.]

The most important acquisition to intellectual activity gained by man is the power of inductive reasoning beyond the penetration of the senses, and beyond sensuous conceptions, and into a realm in which conclusions are reached which are apparently contradicted by the senses and by experience.

[The following are the closing paragraphs of the lecture.]

I have thus endeavored to indicate the course of culture and

characterize its three great stages by following a few lines of its evolution, and I will recapitulate in part, and add other particulars: but that the statement may be laconic, all qualifications and provisos must be neglected.

The age of savagery is the age of stone; the age of barbarism, the age of clay; the age of civilization, the age of iron. The savage propels his canoe with a paddle; the barbarian propels his boat with oars; the civilized man navigates the sea with ships propelled by sails. In savagery, music is only rhythm; in barbarism it is rhythm and melody; in civilization it is rhythm, melody, and harmony. The age of savagery is the age of kinship clan, when maternal kinship is held most sacred; the age of barbarism is the age of kinship tribes, when paternal kinship is held most sacred; the age of civilization is the age of nations, when territorial boundaries are held most sacred. In savagery, law is designed to secure peace; in barbarism, to secure peace and authority; in civilization, to secure peace, authority, and justice. In savagery, law extends only to kindred; in barbarism, to kindred and retainers; in civilization, to all people of the nation. The age of savagery is the age of sentence-words; the age of barbarism, the age of phrase-words; the age of civilization, the age of idea-words. In savagery, picture-writings are used; in barbarism, hieroglyphics; in civilization, alphabets. In savagery there is no verb 'to be;' in barbarism there is no verb 'to read;' in civilization, verbs are resolved into parts of speech. In savagery, beast-polytheism prevails; in barbarism, nature-polytheism; in civilization, monotheism. In savagery a wolf is an oracular god; in barbarism it is a howling beast; in civilization it is a connecting link in systematic zoölogy. In savagery the powers of nature are feared as evil demons; in barbarism the powers of nature are worshipped as gods; in civilization the powers of nature are apprenticed servants. In savagery, men can only count; in barbarism they have arithmetic; in civilization they understand geometry. In savagery, vision is limited by opinion; in barbarism, vision is limited by horizon; in civilization, vision is limited by the powers of the telescope and microscope. In savagery, reason is based on zoömorphic analogies; in barbarism, on anthropomorphic analogies; in civilization, on intrinsic homologies. The great intellectual achievement of savagery was the discovery of the difference between the animate and the inanimate, between the organic and inorganic, between the living world and the dead world, but, the discovery having been made, the animals were deified and believed to be the authors and movers of the world of phenomena; the greatest intellectual achievement of barbarism was the discovery of the limited powers of animals, but, the discovery having been made, the powers and wonders of nature were deified and given the forms of man; the greatest intellectual achievement of civilization was the discovery of the physical explanation of the powers and wonders of the universe, and the intellectual superiority of man, by which he becomes the master of those powers, and the worker of wonders. In savagery the beasts are gods; in barbarism the gods are men; in civilization, men are as gods, knowing good from evil.

The story of human culture is a story of transformations: arts have transformed, institutions have transformed, language has been transformed, opinions have been transformed, and reason has been transformed. There are many strange transfigurations in nature. It is a wonder that the blows of the hammer are transmuted into heat; it is a wonder that the motions of the ether can be transmuted into the rainbow; it is a wonder that the egg can be transmuted into the eagle; it is a wonder that the babe can be transmuted into the sage; it is a wonder that an objective blow may be transmuted into subjective pain; it is a wonder that the printed page may be transmuted into visions of the beautiful: but the wonder of wonders is the transfiguration of selfishness into love. Amatory passion transfigured appears as love; parental care, as parental love; infantile dependence, as filial love; fraternal sympathy, as fraternal love. Thus love of kindred was born; and the love of kindred, by the expansion of the kinship body into the tribe and nation, grew to love of country and love of mankind. The last transfiguration in the process of evolution appears as the ethics of mankind.

Man, so far as he is superior to the beast, is the master of his own destiny, and not the creature of the environment. He adapts

the natural environment to his wants, and thus creates an environment for himself. Thus it is that we do not discover an aquatic variety of man; yet he dwells upon the sea, and derives sustentation from the animals thereof by means of his arts. An arboreal variety of man is not discovered, but the forests are used in his arts, and the fruits of the forests for his sustentation. An aerial variety of man is not discovered, but he uses the winds to propel his machinery and to drive his sails; and, indeed, he can ride upon the air with wings of his own invention. A boreal variety of man is not discovered, but he can dwell among the everlasting snows by providing architectural shelter, artificial warmth, and bodily protection.

Under the influences of the desert, a few plants secure a constitution by which the moisture imbibed during brief and intermittent rains is not evaporated: they become incrustated with a non-porous glaze, or contract themselves into the smallest space, and exist without life, until the rain comes again. Man lives in the desert by guiding a river thereon and fertilizing the sands with its waters, and the desert is covered with fields and gardens and homes. Everywhere he rises superior to physical nature. The angry sea may not lash him with its waves; for on the billows he builds a palace, and journeys from land to land. When the storm rises, it is signalled from afar, and he gathers his loved ones under the shelter of his home, and they listen to the melody of the rain on the roof. When the winds of winter blow, he kindles fossil sunshine on his hearth and sings the song of the Ingleside. When night covers the earth with darkness, he illumines his path with lightning light. For disease he discovers antidote; for pain, nepenthe; and he gains health and long life by sanitation; and ever is he utilizing the materials of nature, and ever controlling its powers. By his arts, institutions, languages, and philosophies he has organized a new kingdom of matter over which he rules. The beasts of the field, the birds of the air, the denizens of the waters, the winds, the waves, the rivers, the seas, the mountains, the valleys, are his subjects. The powers of nature are his servants, and the granite earth his throne.

INFLUENCE OF FORESTS UPON THE CLIMATE OF AUSTRALIA.

IN connection with the discussion that is going on at the present time in reference to the influence of forests upon rainfall in the western parts of the United States, the following remarks of Dr. R. von Lendenfeld on the influence of deforestation upon the climate of Australia, which were published in the February number of *Petermann's Mitteilungen*, will be of interest. The influence of the forest upon the climate in the damp regions of the temperate zone, for instance in central Europe, is undoubtedly such as to increase the humidity of a place. The roots of the trees, forming a network, retain the earth on steep slopes, and thus prevent the water from running off rapidly. On slopes without forest or vegetation the water rushes downward: it is collected in streamlets and rivers, and carried into the ocean before much, if any, evaporation has taken place.

Evidently a great part of the rain falling in a wooded country is evaporated before it can flow off, as the roots of the trees retard its collection in brooks and rivers. Lendenfeld has made some preliminary computations which lead him to the conclusion that about twenty-five per cent of the rain falling in wooded regions of the temperate zone, such as central Europe, are due to the influence of the forest. A country grown with grass and herbs would also have more rain than one in which the bare rocks were exposed to the air.

In Australia the influence of the forest is entirely different from what it is in Europe. The views of those Australians who are principally interested in this matter are divided. The general opinion is that the climate is becoming dryer in consequence of deforestation. Others, however, maintain that the cutting-down of the woods has no influence whatever upon the climate, and that, if such an influence should exist, it is so small as to be of no account, compared to the advantages connected with the deforestation. The latter view is principally held by squatters and ranchmen, who, of course, have an immediate interest in the opening of forest-land for

agricultural and stock-raising purposes, and who cannot be expected to be unbiassed.

Australia is a very dry country, its northern portion alone being exposed to tropical rains. Besides this, only the south-eastern part is mountainous, which has elevations exceeding six thousand feet in height. These elevations—the Australian Alps—materially increase the amount of rain, and thus cause the great productivity of the colonies of New South Wales and Victoria.

Setting aside the Alps and the east coast, the whole of Australia is very dry. The interior is almost rainless; and even near the coast, in the greater part of New South Wales and Victoria, the amount of rain is very small, and does not reach the height of eight inches, while the evaporation amounts to ten feet. In the interior, rain is very rare, occurring only once in a period of about three years. In countries where long-continued droughts prevail, such plants as grow in humid regions cannot live. All plants of the desert, and among them the trees, shrubs, and grasses of the steppes of Australia, have certain means for increasing the water-supply from the deeper layers of the soil (i.e., roots extending to great depths), and others for diminishing evaporation. The *stomata* of many *Eucalypti* are removed from the surface of the leaf, and those of the *Spinifex* of the deserts are protected by a peculiar arrangement. Leitgeb, who has studied the movability of the cells of the *stomata*, found that they close the aperture the more, the less the water at the disposal of the plant.

Besides these well-known facts, Lendenfeld observed that the *stomata* of the leaves of *Eucalyptus* are perfectly closed whenever a hot and dry wind is blowing, so that in such cases no evaporation to speak of takes place. Therefore the same wind which is so dangerous to grasses and herbs has almost no influence whatever upon the *Eucalyptus* trees. Furthermore, Lendenfeld concludes that probably most plants of the desert have their *stomata* closed during the day-time, while they are open during the night. It is only then that carbonic acid enters the plant, and is dissolved in the sap. In the morning they close the *stomata*, and assimilation begins under the influence of the light. The carbonic acid dissolved during the night is decomposed, and the oxygen escapes through the epidermis.

It has been shown by Volkens, that during the latter part of the night the atmosphere, even of the desert, is to a greater or less degree saturated with vapor: therefore the plants do not lose much water by opening their *stomata* at night.

Almost all trees and shrubs of the interior of Australia produce ethereal oils in great quantities. In evaporating, it lessens the temperature of the leaves, and forms a layer of vapor all over the forest. According to Tyndall, air saturated with ether is less permeable for radiant heat than ordinary atmospheric air: thus the tree protects itself by means of a cover of ether from excessive heat and evaporation. As the leaves of the *Eucalyptus* trees turn their edges towards the sun, the effect of insolation is very slight. Thus it is shown that the trees and shrubs of the arid parts of Australia are well equipped to resist the dryness of the climate.

But, besides these plants, numerous small grasses and herbs occur, which Lendenfeld, following Volkens's example, calls ephemeric. They are not at all protected against evaporation. Their roots do not penetrate the soil to any great depth, and their *stomata* are open in the day-time. As their seeds are spread all over the ground in great quantities, they grow up rapidly after every rainfall, and cover the bare ground with a fresh green. They are the principal food of the sheep.

As long as water remains in the upper layers of the soil, the ephemeric plants grow. As soon, however, as the stock of water is used up, they die, as their roots do not extend deep enough. The roots of the trees spread from ten to fifteen feet below the surface of the ground, and absorb all the humidity of these layers which otherwise would gradually reach the surface in consequence of capillary attraction. Thus they prevent the stock of deep water from supplying the needs of the grasses.

In all temperate and humid countries the struggle of the plants is for light. In the interior of Australia, and in other similar sub-tropical regions, they struggle for water. Thus the ephemeric plants are here killed by the trees, and in wooded countries they do not occur at all.

Lendenfeld, while travelling through the wooded parts of Australia for days and days, did not observe a single blade of grass. The soil, which consisted to a great extent of red clay, was smooth as asphalt pavement, and hard as rock. Rain, when falling on such soil, does not penetrate it, but runs off rapidly. The low-lying regions are inundated; but it appears that the water is not evaporated there, but flows through subterranean channels into the ocean. There are no rivers with large watersheds in Australia. Even the largest river, the Murray, is navigable only in winter and for light steamboats.

The water runs off so quickly that it has hardly time to penetrate the hard and smooth ground. The woods, therefore, do not increase the humidity of the soil and of the air.

In many places the squatters begin to cut down the trees, so far as the laws permit their doing so. The local effect is marvellous. Lendenfeld observed that so many kinds of grasses began to grow, that on the same space on which, before the cutting-down of the trees, only one hundred sheep could be raised, a thousand found sufficient food.

This effect is brought about in the following way. As the trees do not absorb the humidity of the deep layers of the ground, it reaches the surface and is absorbed by the grasses. The decaying stems of the grasses form small channels in the soil, which lead to larger ones that were formerly occupied by the roots of the trees. Thus the ground becomes permeable for water. When rain falls, it runs off slowly, as the grasses hinder its movements. It penetrates the ground, and thus a greater portion of the total amount of rainfall benefits the spot at which it falls. Part of it evaporates, and thus increases the humidity of the air.

It has been said that the springs become more numerous by the cutting-down of the woods, as the grasses do not use the humidity of the deeper layers of the ground. Lendenfeld, however, maintains that the increase of water carried by the springs is not as great as the increase of water retained in the soil through the action of the grasses, and that a great part of the water of springs is evaporated, and increases the humidity of the air.

From all these facts, Lendenfeld concludes that in Australia the effect of deforesting the country is not a decrease, but an increase, of rainfall.

NEW ZEALAND LETTER.

THE long-continued commercial depression under which this colony still labors affects every class of the community, and is working a quiet, but in some respects much-needed, revolution in the habits of the people. There is no doubt that the colonists in former years had no ideas of economy in any direction; but these are now being forced on their notice in all sorts of ways. Early in last session of the Colonial Parliament, the Stout-Vogel ministry was overthrown, and Major (now Sir Harry) Atkinson assumed the reins of office, under strict pledges to enforce retrenchment in every possible direction. As far as the public can judge, these pledges are being fulfilled fearlessly and without favor.

In matters educational the primary-school system and the University of New Zealand come directly upon government for assistance. The former is altogether, and the latter to a considerable extent, dependent upon the annual appropriations made by the legislature. Considerable reductions have been made in the amount allotted for primary schools; but, as is so often the case, these reductions have not been effected in perhaps the best directions. Thus it was considered advisable to contract the school age at one or both ends. At present it commences at five years of age, and it was proposed to raise it to six. This would have disposed of the charge so often brought against the infant classes, especially of country schools, that they are merely convenient nursing-depots, where the younger children of a family are kept warm and out of mischief for a great part of each day. But the House of Representatives, in their wisdom, saw fit to retain the school age at five, but to knock off the highest or seventh standard. In times of depression, when it is difficult to find occupation for either old or young, it is commonly noticed that boys who have completed their sixth standard work are sent adrift to loaf on their parents, who cannot get them any work to do. For such a class alone, it would have been economy to keep the upper standards open, even had a small

fee been charged. No education is so bad as that of the streets and of enforced idleness.

Another possible and profitable source of retrenchment in this much-overgoverned community would have been the abolition of some of the smaller education boards. It seems absurd, that, with a small population of some six hundred thousand, there should be something like twelve education boards, each with its paid staff of officials,—secretary, inspectors, etc. The abolition of at least six of these would have made a substantial reduction in the education vote: but, as it would have weakened or endangered the position of many of our precious representatives, it was not even considered, but, instead, the training-colleges at Auckland and Wellington were abolished; so that no adequate provision now exists in the North Island for the education of teachers. The free, secular, and compulsory system of primary education of this colony is one of the things the community is proud of, but it is a decidedly retrograde step when provision for adequately training its teachers is not made.

Secondary school education is all carried on in specially endowed schools, governed mainly by separate boards, and practically independent of the education department. Private enterprise in this direction is so handicapped by the endowments, that, except in a few cases of very special class schools, there are no private schools in the colony. A determined effort is made by a certain section of politicians to capitalize all these endowments for the benefit of the colony, and especially of primary education, and thus make secondary education dependent upon the support it might receive from those classes most able to provide it. Such a measure, if carried into effect, would close the avenues of the higher education to the poorer classes; while at present, owing to the low fees charged at the high schools (averaging from \$50 to \$62.50 per annum), and to the liberal provision made for scholarships, every boy or girl of promise in the primary school has a good chance of continuing his or her education in higher subjects at the public expense. While the secondary schools have not, in most cases, been retrenched directly, yet, as the revenues from their endowments have in nearly every case fallen considerably, the salaries of all their teachers have had to be correspondingly reduced.

The teaching of science occupies a very fair place in the curricula of New Zealand schools. In the primary schools very little is attempted beyond a few lessons in physics, physiology, or chemistry in the higher classes of the better schools. But alongside of this, rather heavy demands are made upon teachers going up for their examinations. Indeed, some knowledge of so many science subjects is demanded of them, that this part of the examination for classification defeats its own object. Were each teacher permitted to select one or two branches of science, and were they expected to attain a fairly high standard of efficiency in it, the introduction of really good science-teaching in the schools would soon follow, and indeed could be demanded.

In the secondary schools, provision of a kind is usually made for teaching one or two branches, although in only two schools in the colony is there a science-teacher who is a specialist. In most cases one of the staff is selected for his knowledge of some scientific subject; while the head master, being nearly always a classical scholar, does not, as a rule, attach a very high value to this department of school-work. This, however, is counterbalanced to a great extent by the importance which the New Zealand University attaches to science in its junior scholarship examinations, whose requirements constitute in many cases the guiding lines of the curricula of the high schools. For example: at the examination held last December, out of 60 candidates, 12 offered in botany, 26 in chemistry, 11 in mechanics, 14 in heat, 6 in electricity, and 1 in sound and light; that is to say, that, as each candidate who took science had to select any two subjects, 35 had offered themselves in this section of the examination. Most of the schools have either a small laboratory or at least a small stock of materials for teaching chemistry and some elementary physics, but little or none for the more specialized branches of the latter.

It is difficult for one not acquainted with the actual standards attempted, and the results gained, in schools of other countries, to compare the work done in our educational establishments with that done elsewhere. At the same time it is a fact that the medi-

cal students, who, after taking the early part of their training in the colonial high schools and colleges, proceed to Edinburgh to complete their course, invariably give a very good account of themselves.

In matters of purely scientific interest there is but little to chronicle at present from the colony. The want of money seems to have paralyzed even much of the available energy of the colonists; many men who formerly thought themselves in possession of a competency for the rest of their lives, being under the necessity again of commencing the grim battle for bread. It must be borne in mind that there is practically no cultured class in the colony, outside of those who are compelled to work. The scientific research and work which have been put forth from these islands have been done usually in the course of, or in the intervals of, hard professional work, by settlers, surveyors, medical men, lawyers, and teachers. There is only one purely scientific association for the whole colony,—the New Zealand Institute; formed, however, of a number of affiliated societies, each having its own rules, office-bearers, funds, etc. The chief of these are the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury (meeting in Christchurch), and the Otago Institute (meeting in Dunedin). Besides these, there are smaller branches at Napier, Nelson, Hokitika, and Invercargill. The central body, termed the New Zealand Institute, is practically only an administrative board, partly elected by the affiliated societies, but chiefly nominated by the governor. This body is charged with the publication of the papers on scientific matters, which are read before the various affiliated societies; and these constitute a bulky octavo volume, containing last year nearly seven hundred pages. The management of the whole is in the hands of Sir James Hector, director of the Geological Survey, who indeed has been the central figure of the institute since its establishment in 1867. A government grant of £500 per annum meets the chief cost of publishing the annual volume of Transactions and Proceedings, but this is occasionally supplemented by small levies on the affiliated bodies. The total number of members of the various branches of the institute is about 1,250,—a most creditable number, when the population of the colony is considered, and when it is borne in mind that each of these is a voluntary member and subscriber to the extent of at least a guinea a year. The pages of the nineteen volumes of Transactions teem with valuable papers on many branches of natural science, zoölogy and botany having the largest number of votaries. The isolated position of the colony makes the study of its groups of plants and animals peculiarly complete from the point of view of geographical distribution. Hence many European specialists have devoted some of their time to working out all the New Zealand forms of one or other group. Thus at present Baron Osten-Sacken is engaged on the *Diptera*,—a group regarding which very little is known in the colony, but the members of which take a large share in the fertilization of its flowering plants. Mr. E. Meyrick has systematically studied many groups of the *Micro-lepidoptera*, and is still engaged on others. The New Zealand *Araneæ* were formerly only known from the Rev. O. Pickard-Cambridge's papers, in the London Zoölogical Society's Transactions. Now, however, they are being taken up by Messrs. Urquhart of Auckland, and Goyen of Dunedin, both of whom are doing very good work. At present, as has mostly been the case in the past, the chief work done in the colony has been systematic; and even this has been done under great difficulties, the principal one being the impossibility of consulting all the literature of any subject.

Some two years ago the Royal Society of England made a grant to Prof. T. J. Parker of Dunedin to aid him in working out the embryology of the Tuatera lizard (*Sphenodon*), and also of the Kiwi (*Apteryx*). Living specimens of the former were obtained and kept in confinement both by Professor Parker and by Professor Thomas of Auckland, but up to the present time no eggs have been laid. But the study of the embryological development of *Apteryx* has been prosecuted much more successfully, and zoölogists may shortly expect a communication on the subject to the Royal Society, which will contain many points of interest.

Matters geological, especially those relating to mining, bulk much more largely in people's minds here than any other questions of a scientific kind. It is felt that New Zealand must look in the future

more to her mineral wealth for her prosperity than ever she has done in the past, and it is in this quarter that most of the available capital is being directed—or, one might say, misdirected. A great amount of money is sunk in unscientific ways of mining and of prospecting. The country teems with mineral wealth, but it wants more knowledge, and less blind working. Very many of the mining ventures have turned out, as indeed is the case everywhere, unsatisfactorily. Copper-mines have been opened in various parts, but none are now in operation. Antimony occurs abundantly, but has never been profitably worked. The enormous deposits of iron-sand on our sea-beaches are still practically unworked. An attempt is being made to work the oil-bearing beds of the east coast of the North Island, but it is impossible to see how the projectors can successfully compete against the cheap oils of Pennsylvania. The one great stand-by of the colony is gold, and the crying want of the miners is some method of saving the fine gold which at present is lost. When it is seen that the 'tailings' of the famous Blue Spur diggings, which have been washed over several times, are still being sluiced by Chinamen who are making from two dollars to three dollars a day, it is clear that the art of gold-saving is still in its infancy.

Within the last few months a number of Wellman's dredges have been constructed to attack the beaches of auriferous sand and the river-beds. As these come into use, the quantity of gold obtained will be increased, and the available extent of field much enlarged.

G. M. T.

Dunedin, Feb. 23.

GRÜNWALD'S THEORY OF SPECTRUM ANALYSIS.

THERE has lately been advanced by Professor Grünwald of Prague a theory of the change which the spectrum of a substance undergoes when that substance enters into combination with another, that is so extremely simple that it is difficult to see how it can possibly be true. But the number and exactness of the coincidences that Professor Grünwald has observed are such as to arrest attention, and give some interest to the theory which is based on them.

The discoverer states, that, by a mathematical investigation of the changes which the spectra of two gases undergo when brought into chemical combination, he has been able to establish a law, as simple as it is important, which may be the basis of a future mathematico-chemical analysis; and by the aid of this law he has been able not only to establish a very remarkable relation between the spectra of hydrogen and oxygen on the one hand, and that of water-vapor on the other, but also to discover the chemical composition and structure of hydrogen and oxygen, and bring out the facts of the dissociation of hydrogen in the atmosphere of the sun.

The fundamental theorem of this new mode of analysis is as follows. Suppose we have a chemical element a , which, when combined with some other elements, forms a gaseous substance A . When the gas A unites with some other substance, a chemical compound B is formed, in which the element a is also contained, but in a different condition from that in which it existed in A . Usually the atomic volume of the substance a , reckoned in the ordinary way in use among chemists, will be different in the last case from what it was in the first, and the ratio of the atomic volumes in the two cases will be expressed as a ratio of two simple whole numbers. The above being granted, the theorem asserts that those wave-lengths of light in the spectrum of the substance A that belong to the element a are to the wave-lengths due to that element in the spectrum of the substance B in the same ratio as the atomic volume of a in A is to its atomic volume in B .

It follows from the above, that, when the atomic volume is unchanged by the combination, the wave-lengths of the lines due to the substance will be the same in both cases. But great variation between the spectra may exist notwithstanding, because, as Professor Grünwald remarks, the amplitudes of some of its modes of vibration may well be very different in the one case from what they are in the other. This, of course, means that the intensities of lines may be so different in the two cases that stray lines in the one spectrum may be so faint as to seem entirely lacking in the other. Thus, when hydrogen combines with chlorine, bromine, or iodine, the resulting gases, HCl , HBr , and HI , are formed without change

in atomic volume; and hence the spectrum of HCl, for example consists simply of the spectrum of hydrogen combined with that of chlorine, with certain changes in the intensity of some lines.

In comparing the spectra of hydrogen and water-vapor, it was found that wave-lengths of the lines of the so-called H^d or compound line-spectrum of hydrogen, which has been investigated by Hasselberg, were twice those of the corresponding lines in the water-vapor spectrum. This conclusion was arrived at by comparing with the comparatively few lines of the water-spectrum that were accessible at the time. To test the conclusion, however, a list of wave-lengths that should be in the water spectrum was drawn up and sent to Professor Liveing at Cambridge, and the wave-lengths compared with those obtained by Liveing and Dewar in their recent experiments. As the result of this comparison, the author publishes a list of nearly sixty lines between wave-length 2800 and 2450, in which to each estimated line there corresponds an observed one; the difference between the observed and calculated wave-lengths in no case amounting to more than one Angstrom unit, or 1 part in 2,500.

The author therefore concludes, on the basis of his theory, that hydrogen, in that condition in which it gives this second or compound line-spectrum, occupies twice the atomic volume which it has in water-vapor.

The primary or elementary line-spectrum of hydrogen, however, it was found might be divided into two groups of lines, in such a manner that the wave-lengths of the one group when multiplied by $\frac{3}{2}$, and of the other when multiplied by $\frac{4}{3}$, gave the wave-lengths of the corresponding lines in the H_2O spectrum. Whence the author, by means of his fundamental theorem, reasons thus: hydrogen is formed of two primary elements, which may be designated a and b , and which give rise to the two parts of the elementary hydrogen spectrum under each other's influence. Let a and b represent the volumes of these two substances respectively in unit-volume of hydrogen; then $a + b = 1$; and, since hydrogen occupies two-thirds the atomic volume in water-vapor that it does in the primary condition, from the fundamental theorem we have

$$\frac{3}{2}a + \frac{4}{3}b = \frac{2}{3}.$$

From these two equations,

$$a = \frac{4}{5}, \quad b = \frac{1}{5};$$

therefore hydrogen is a combination of the form $H = ba$, and is thus analogous to ammonium (NH_4), and, as Professor Grünwald asserts, will, on dissociation, expand in the ratio of 3 to 2.

The primary element a must be a gas many times lighter than hydrogen. The spectra of these two elements, a and b , in the free condition may be at once obtained from the hydrogen spectrum by the previous theorem, when it is granted that the gas, on dissociation, expands in the ratio of 3 to 2; for we have only to multiply the wave-lengths of the group a in the hydrogen spectrum by $\frac{3}{2}$ to obtain those of the substance a in the free condition; and in like manner the wave-lengths of the substance b may be obtained from the corresponding group b .

Professor Grünwald has tabulated five lines in the spectrum of a between wave-lengths 9842 and 5653, and about forty lines of the spectrum of b , and each is found to correspond with a line in the solar spectrum. He concludes, therefore, that hydrogen, in the dissociated condition, exists in the sun, and identifies one of the lines of b with the so-called Helium line, 5874.9 of Angstrom's scale, while reasons are given for believing the corona line (1,474 of Kirchhoff's map) is one of those in the spectrum of a . These two component elements of hydrogen he therefore suggests might be named 'Coronium' and 'Helium.'

From similar considerations to those employed in the case of hydrogen, oxygen, in its simplest molecular condition, is found to consist of the modified hydrogen, which gives the secondary spectrum before mentioned, with an equal volume of a substance O' , with which it combines without change of volume. This O' is a combination of four parts by volume of the same element (b) which was found in hydrogen, with five parts of another substance (O''), which is itself composed of four parts of b with five parts of an unknown primary substance c . The formula expressing the above is,

$$O = H' [b_4(b_4c_5)_5].$$

In a long paper published in December in the *Sitzungsberichte*

der Kais. Akad. der Wissenschaften of Bohemia, Professor Grünwald has extended his work to the spectra of magnesium and carbon, employing the wave-lengths as determined by Liveing and Dewar, and Hartley and Adeney, with the result that the spectrum of magnesium may be separated into four groups. The first is due to 'Helium,' neither 'condensed nor dilated;' the second is that of the primary element c in the condition in which it exists in oxygen; the third is that of b in the state in which it exists in free hydrogen; while the fourth is caused by the same element b , but in the chemically more 'condensed' state in which it exists in water-vapor.

There are still a number of weak magnesium lines which fall naturally into these groups, but the corresponding lines to which in the hydrogen and oxygen spectra are not known to exist. Carbon has similarly been resolved into a certain compound of these elements b and c .

These speculations will require most thorough investigation and testing before they can be accepted; but the first point to be seriously examined is the basis on which they rest. If the coincidences reported by Professor Grünwald, when examined carefully, are found sufficiently close and numerous to prove that a large group of lines in the spectrum of one substance can be obtained by simple multiplication by a constant multiplier from a corresponding group in the spectrum of another substance, and if there is any other fact, such as the regular periodic arrangement of the lines, which would seem to connect that group of lines together, then it is one of the most important facts which have yet been developed in connection with spectra. But it is necessary that the agreement should be of the same order of accuracy as the errors in the determination of wave-lengths, and there should appear some other fact connecting a group of lines together. As to the 'condensation' theory, nothing need be said until the facts are more thoroughly worked up; but the remark of its author, that the intensity of the lines due to a substance will experience great differences in intensity in different combinations, while undoubtedly true, gives great elasticity to the theory, and admits of its adaptation to so wide a range of facts as to seriously weaken the evidence advanced in its favor.

HEALTH MATTERS.

Diphtheria in New York.

THE prevalence of diphtheria in New York and Brooklyn has awakened a renewed interest in the means for its prevention. A paper on this subject was recently read by Dr. A. Caillé before the New York Academy of Medicine, and is reported in the *New York Medical Journal*. It had been his experience, as it probably had that of many other physicians, that in certain families one or more members regularly had diphtheria in the spring or autumn. This was particularly true of children. It had occurred to him that such persons might harbor the microbes, or other essentials to the development of the disease, in the nasal and oral cavities. The germs of diphtheria would readily take hold of damaged mucous membrane.

In trying to establish the correctness or fallacy of this view of self-infection, he had selected eight cases, in all of which the patients had suffered from true diphtheria twice or more prior to October, 1885. The families were well known to him, and they had occupied the same houses or had the same surroundings for a number of years. The parents of the children were intelligent enough to carry out his instructions. All carious teeth were to be filled or extracted, the teeth to be examined from time to time; the mouth was to be thoroughly rinsed three times a day, after each meal, with either a three-per-cent solution of chlorate of potassium in water, a five-per-cent solution of *liquor soda chlorata*, or a saturated solution of borax in water. Besides using it as a mouth wash and gargle, some of the solution was to be drawn into the nose. From October, 1885, to December, 1887, not one of the persons experimented upon suffered from diphtheria, although five of them had several attacks of acute pharyngitis and amygdalitis. There was diphtheria in the family of three of the number, but they did not contract the disease. While these cases were insufficient to furnish absolute proof of the benefit of such prophylactic measures, yet they went far to establish the belief, that, if the nasal and oral

cavities were kept clean by a mild antiseptic solution, the frequency of diphtheritic inflammation would be decidedly reduced.

In the discussion which followed, Dr. A. Jacobi, president of the academy, said that he believed it to be true that the diphtheritic poison could remain in the mucous membrane, and particularly in the neighboring lymphatic glands. Persons with a healthy mouth and pharynx were less easily infected than those who had catarrh of any form. The slightest scratch might give rise to erysipelas, and the same was true of diphtheria. One point in the prevention of diphtheria was of great importance: everybody had seen cases in which the patient was apparently about getting well, but suddenly had a new attack; and the attacks might thus be renewed four or five times. This was due to infection from the curtains or other things in the room occupied by the sick. In these cases prevention of renewed attacks was possible. If there were only two rooms, the child should be transferred from the one to the other at intervals of a few days, and the vacant room cleansed and thoroughly ventilated, and, if possible, disinfected. Dr. Holt believed that enlarged tonsils favored the development, and made the attack more severe.

DIPHTHERIA CARRIED BY TURKEYS.—Dr. Paulinis, in the *Bulletin Médical*, reports a most interesting epidemic of diphtheria which occurred in Skiotos, one of the Grecian isles, in the year 1884. The population of this island at the time was about four thousand. Dr. Bild, an old practitioner, is the authority for the statement that for thirty years no case of diphtheria had been known on the island. In June a child aged twelve years was attacked with diphtheria, and died. Seven other cases occurred in the immediate neighborhood: five of these died. The disease extended, until, within a period of five months, one hundred persons were attacked, of which number thirty-six died. Three weeks before the sickness of the first child, a flock of turkeys arrived from Salonica. Two of these were sick on arrival, and each of the others was subsequently attacked. Dr. Paulinis found in the throats of the sick ones patches of false membrane. The glands of the neck were swollen, and in one bird the disease had extended to the larynx, making it hoarse. One of the turkeys, after recovery, had paralysis of the legs, and was unable to walk. Although there had been no immediate contact between the sick birds and the first child attacked, still the distance between them was slight, and a wind had been for some time blowing in a direction favorable to the transportation of the disease. Dr. Paulinis believed that the disease was contracted from the turkeys, its germs being carried by the currents of air.

LEAD IN WATER.—From a report on the recent progress in public hygiene by Dr. Samuel W. Abbott to the *Boston Medical and Surgical Journal*, we abstract the following: In Sheffield, England, cases of lead-poisoning have been very frequent; during the past winter there has been an alarming increase, the number amounting to several hundred. On inquiry, it was found that these were quite exclusively among the population supplied from the high-service reservoir, in the water of which lead was found in quantity varying from half a grain to one and a quarter grains per gallon. This water was found to be distinctly acid, claimed to be of vegetable origin, arising from the peat upon the moors. To neutralize this acid, and thus prevent its dissolving the lead in the pipes, blocks of limestone have been placed in the conduit by the water company. The public analyst does not approve of this, saying that too much limestone will injure the water, and render it as liable to act on lead as if it had not been thus treated. He advises that the lime be introduced regularly and constantly in powder, or as milk of lime. Charcoal filters have been efficacious in removing the lead, in consequence of the phosphates contained in the animal charcoal used, forming an insoluble phosphate of lead.

PURE WATER FOR VIENNA.—Since the introduction into Vienna of a pure water-supply, the mortality from typhoid-fever has been greatly reduced, as well as that from other diseases. Since 1880 there has not been a death from dysentery in the city. Up to 1861 there were ten thousand wells in use in the city, and also public and private aqueducts bringing water from the Danube Canal. Although it is not so stated, we infer that these all have been aban-

doned. As a result of this improvement in the public health of Vienna, it would appear that water is the principal agent in the transmission of typhoid-fever, and that, in order to cause this disease almost entirely to disappear from a large city where it is endemic, it is only necessary to furnish to the inhabitants water of unquestionable purity, and in sufficient quantity.

DISINFECTION OF LIBRARY BOOKS.—The danger of infection from the use of books from circulating libraries has received intelligent attention in England, and means have been devised for their disinfection. The principal one which disinfection is based is the vaporization of carbolic acid by heat, whereby it is claimed that its action is more potent. Heat is applied to the outer casing of an apparatus, which is fully under control, so that a temperature which might injure the books can be avoided. The heat employed is from 150° to 200° F., the books being subjected to this temperature for fifteen minutes, and not injured by the process. The apparatus is said to be patented.

MORPHINE HABIT IN PARIS.—It is said that in Paris thousands of women are cutting short their careers by the use of morphine. Morphine disks are dissolved in a small bottle of water, and this is placed in a case which includes a tiny syringe. The whole apparatus is of a miniature description, and can be conveniently carried inside the smallest muff. The vice has become so fashionable that women actually fill their syringes before starting for the theatre, and thus have the means at their disposal, any moment, of injecting themselves with the drug while lounging in the *fauteuils* or in their boxes.

PASTEUR.—Pasteur and his treatment of hydrophobia—two topics which occupied the attention of the scientific world for so long a time—have hardly received even a mention of late either in the medical or the popular journals. Two of the patients treated by Pasteur for rabies have died during the present year. One of these was a boy, aged four, who was bitten by a mad dog on Dec. 6 last, and was under treatment at Pasteur's Institute from the 12th of December, 1887, until the 7th of January this year. He died of hydrophobia on Jan. 22. The second case was that of a woman, aged fifty-two. She was bitten on Jan. 23 of the present year, and was placed under Pasteur's treatment on Jan. 29. She died on Feb. 17 of hydrophobia.

ILLUMINATING-GAS.—A remonstrance largely signed by the physicians of Massachusetts has been presented to the Legislature of that State against the passage of any law allowing the manufacture of illuminating-gas containing more than ten per cent of carbonic oxide, as the intensely poisonous properties of that element of gas are well known, and are dangerous to health and life.

TYPHOID VACCINATION.—Chantemesse and Vidal communicated to the Société de Biologie some interesting observations on vaccination against typhoid-fever, claiming that in mice inoculated with cultures of typhoid bacilli a disease is produced with lesions the same as in human typhoid-fever. Mice inoculated with bouillon in which colonies have lived, but which no longer contain the bacilli, resist subsequent inoculation with the most intense typhoid virus.

ELECTRICAL SCIENCE.

Central Station Lighting.

ONE of the most interesting and important contributions to the question of alternating *versus* continuous currents for electrical distribution is the paper of Mr. Crompton, read before the English Society of Telegraph Engineers and Electricians. Mr. Crompton takes up the questions of expense of installation and of working, for two stations; one using alternating currents, the other using continuous currents and storage-batteries. The estimate for installation differs slightly from that given in a previous paper by the same author, an abstract of which was given in this journal, and enters much more into detail.

Mr. Crompton considers the cost for 10,000 lamps, to be supplied at one time from the central station. For the batteries the plan he advocates is the establishment of sub-stations where the storage-cells are to be placed. The lamp-circuits are permanently con-

nected to the batteries, which really are more used for transforming the comparatively high potential employed than for storing the electrical energy. The batteries are of such a capacity that they can supply one-third of the energy required during the time that the maximum number of lights exceeds the capacity of the central station. If the maximum energy required is 600 kilo-watts, the central station will only have a capacity of 400 kilo-watts; the battery supplying the remaining 200 when it is needed, and being charged when the demand falls below 400 kilo-watts, the capacity of the station. It will be found, however, that this plan does not utilize the storage-battery to the full extent possible, as the central station will be idle for part of the twenty-four hours. What it does, however, is to diminish the size of the central station and equipment by one-third, and allow the electrical energy to be distributed at a high potential, by comparatively small conductors. The potential Mr. Crompton proposes to use is in the neighborhood of 450 volts, a value which seems rather low.

For the alternating system a potential of 2,000 volts is assumed, with a transformer for every one or two houses. Calculating the cost of installing the above plants, Mr. Crompton finds that the alternating system will come to £57,440; the direct system, with storage-batteries, £59,762. In calculating the running expenses it is assumed that the batteries deteriorate only fifteen per cent per year, an extremely low estimate. The following is the estimate of working expenses for a year:—

	Accumulator.	Transformer.
Materials (coal, etc.).....	£2,517 os. od.	£4,648 os. od.
Labor and salaries	1,995 0 0	2,608 8 0
Maintenance of plant.....	4,086 10 0	4,683 5 0
Total.....	11,939 13 0	8,598 10 0
Cost per unit.....	3.75d	2.7d

These results, provided they were true, would be very encouraging, since they would allow electric lights to be sold at a price that would correspond to gas at seventy-five cents per thousand, with an extremely handsome percentage on the original outlay. Mr. Crompton has omitted in his estimate the cost for rent and attendance at the battery stations,—items that would add about £1,000 per year to the accumulator account, but which would still give a balance in its favor. While in this country the conditions of distribution are different, a plant of 10,000 lights being smaller than would be built in any large city, yet the comparative values given will not be greatly modified; and when we consider that here the distribution of power must be taken into account, and credited to the direct system,—power distribution being impossible at present with alternating currents,—the moral of Mr. Crompton's figures seems to be that the alternating system has no place in densely populated centres, but must be relegated to towns and the suburbs of cities, where there is a field for it as wide as its most enthusiastic disciples can wish.

ELECTRIC STREET-CARS IN BALTIMORE.—In the last few weeks a car equipped with electric motors and storage-batteries has been running in Baltimore, with a success that promises at least a systematic experiment to determine the expense and the value of the system. The condition of the street-railway tracks in Baltimore—the heavy grades and sharp curves—is such that the demand on a secondary battery is very trying; there is also a heavy demand on the motors, which must develop as much as 20-horse power for considerable distances. In order to avoid too heavy a discharge-rate from the battery, a larger number of cells are employed than would be ordinarily used. The details of the equipment are as follows: the car is a large sixteen-foot car, furnished with two Sprague motors of $7\frac{1}{2}$ -horse power each, capable of working up to over 10-horse power. The gearing is the ordinary gearing of the Sprague system, and has been described in this journal. The weight of the motors and gears is about 1,600 pounds. The battery consists of 126 cells placed beneath the seats, arranged in boxes of nine cells each. The cells are of the grid type, manufactured by the Accumulator Company under the patents of Faure,

Sellon, Swan, etc.; the Electrical Storage Company of Baltimore having the patent rights for Maryland, the District of Columbia, and West Virginia. The cells weigh about 4,200 pounds, and the total weight of the car is 13,000 pounds. Before the car was tried, there was considerable doubt, even among members of the company, whether it would successfully take the heavy grades that the track offers. It has been running, however, for several weeks with excellent results: it ascends the steepest grades with ease, and much faster than do horse-cars; there is very little noise; the car is under most perfect control; and, as far as performance goes, it is a decided success. The question of cost has yet to be settled. If we take a number of cars, and if the street-car company supplies its own power, the cost per car per day for power will not exceed \$1.75, counting all the expenses excepting only the deterioration and handling of the battery. As the cost of horse-power per car per day for the same service is not less than \$6, the margin for repairs and attendance is about \$4.25 per car per day. Whether that amount will suffice can only be determined by trial; but if every precaution is taken, and if the battery and motor are properly designed for the work they have to do, it is probable that the expenses will not be greater than the cost of horses. As to the increased comfort, there is no question.

SUSPENSIONS FOR GALVANOMETERS.—Dr. G. A. Liebig, in an article in the *Electrical World*, gives the results of some experiments on different kinds of silk for galvanometer suspensions. If ordinary silk fibres be used to suspend delicate astatic systems, there will be found some trouble from capricious movements of the needles. Dr. Liebig shows that these are probably due to two things. In the first place, an ordinary fibre of silk obtained from a cocoon consists of two single fibres surrounded by a "gummy substance of a gelatinous nature," the last making up about one-third the bulk of the fibre. The disturbing effects seem due to, in the first place, not separating the two parts of the double fibre; and, in the second place, to the changes in the outer gelatinous coating from moisture, etc. The remedy lies in using only a single fibre, and in washing it in hot water, dissolving off the coating. The variety of silk known as 'tussus' is especially recommended, a single fibre being able to sustain from five to seven grams, as against two grams for ordinary silk.

BOOK-REVIEWS.

Ancient Legends, Mystic Charms and Superstitions of Ireland.
By LADY WILDE. Boston, Ticknor. 12°. \$2.50.

THE present volume contains a great number of legends and current beliefs of Ireland, collected by an enthusiastic lover of the island and of its people. Many of the legends were directly obtained from oral communications, and the simplicity of the style in which they are told adds to their attractiveness. The contents of the volume are of great variety. A number of legends treating mainly of fairies and kindred subjects is followed by a description of festivals and myths referring to their meaning and origin. Marriage rites and mortuary customs are fully described, and in reading these we were much pleased with the author's remark that there is nothing derogatory to grief in the idea of hired mourners. "On the contrary," she says, "it is a splendid tribute to the dead to order their praises to be recited publicly before the assembled friends; while there is something indescribably impressive in the aspect of the mourning women crouched around the bier." It is this endeavor of the author to present usages, superstitions, and beliefs from the standpoint of those who hold to them, which makes the book particularly valuable, and attractive to the reader. It seems to us that the author has been eminently successful in this attempt. A special chapter treats of medical superstitions. A comparison of these remarks with Mr. Mooney's paper mentioned in a recent number of *Science* will be of interest. Legends referring to the sidhe and banshee receive special attention, while there are comparatively few treating of the saints and their exploits. The theories of the author regarding the origin of the various legends and customs occupy only a small portion of the book, and will hardly stand a severe test. The appendix, which treats principally of the antiquities of Ireland, of early Irish art and the ancient

capital, — is full of enthusiasm for the early history of the country. Appended is the address of Sir William Wilde to the Anthropological Section of the British Association, delivered at Belfast, 1874.

Alden's Manifold Cyclopædia of Knowledge and Language. Vols. I.-V. New York, Alden. 12°. 50 cents per vol.

THE most striking features of the present cyclopædia are the handiness of its volumes and its cheapness, which will make it accessible to the general public. Another remarkable feature of this work is the combination of the characteristics of a cyclopædia and of a dictionary, including in its vocabulary every word which has a claim to a place in the English language. The sources from which it draws are the standard cyclopædias and dictionaries, and therefore the contents of the various titles are probably accurate. A considerable number of illustrations have been inserted in the text for illustrating the subjects treated. Considering the marvellously low price of the volumes, the printing is very satisfactory, the type being clear and sufficiently large. In selecting the titles, and in their treatment, special attention has been paid to the wants of the American public; and those who are unable to procure one of the expensive large cyclopædias will find this work useful. So far, five volumes have been issued, bringing the cyclopædia up to the word 'brave.' The work, when completed, will consist of about thirty volumes.

Practical Hints for Draughtsmen. By CHARLES WILLIAM MACCORD, New York, Wiley. 4°. \$2.50.

"THE leading object of this treatise is to explain various modes of representation, which are in many cases better than the precise ones of projection." These words of the preface define clearly the scope and object of the present volume, which is of the greatest value to the student of mechanical drawing. The author is particular in emphasizing the fact that the object of the draughtsman is not to make such drawings as are correct from a theoretical point of view, but working drawings that will serve the purposes of the workman, and that the method will be best which reaches this object with the least outlay of time and labor. These principles are so sound, and their application is set forth so clearly, that the book must be recommended to all students of mechanics. The author, recognizing the difficulty of laying down the rules in which it is advisable to deviate from the laws of projection, shows in a great number of examples in which way the working drawing ought to differ from a correct projection, and emphasizes especially the necessity to omit details which are of no use to the workman. The maxim, which he advocates most strongly, that each view should be made to tell all it can, but that nothing should be put in it which does not tell something worth knowing, ought to be kept in mind by every mechanical draughtsman. A special chapter is devoted to the representation of bolts, nuts, screws, and rivets. His hints for sketching will be found eminently practical. In an appendix a description is given of drawing-instruments, intended as a guide for selecting a good set. Although we agree with the author's opinion in a general way, we cannot concur in his wholesale condemnation of instruments adapted for special purposes.

Memoranda on Poisons. By THOMAS HAWKES TANNER. 6th ed. Rev. by Henry Leffmann, M.D. Philadelphia, Blakiston. 24°. 75 cents.

TANNER'S 'Memoranda on Poisons' is so well known, that it is only necessary to call attention to the differences which exist between this and former editions. The principal changes that we notice are the substitution of modern chemical nomenclature for the older style, and the revision of the toxicology of poisonous food. Although this book is specially intended for those engaged in actual medical practice, it will be found to be a valuable addition to every library, containing as it does, in a very condensed form, the symptoms and treatment of poisoning in its many forms.

NOTES AND NEWS.

THE value of the work now doing by the United States Geological Survey will be appreciated when it is known that the engineer of the Denver and Rio Grande Railroad located its line through the passes of the Wasatch Mountains from the government maps with-

out sending out parties to determine the best route. The engineer of the projected line from Los Angeles to Salt Lake City made similar use of the National Survey maps; and, wherever engineering-work is to be done in territory which has been covered by the survey, it has been found to be of the highest practical usefulness.

—Eight field-parties left Washington on Sunday to begin the work of the National Survey for the season on the Pacific coast. Three have gone to the gold-belt of California, under the direction of Mr. H. N. Wilson; two to the Cascade Mountains in south-western Oregon, under Mr. W. T. Griswold; and three to Montana, under Mr. J. M. Douglass. The charts they are making of California are on a scale of two miles to an inch, and those of Oregon and Montana four miles to an inch. The California parties will cover an area of about two thousand miles each during the season, and those in Oregon and Montana from three thousand to four thousand miles each. The parties that are going to south-western Oregon are to work in a region which it is believed will develop into a great gold-bearing country. It has already yielded a large amount of placer gold, but the gold-bearing quartz has not yet been developed. The survey will probably direct attention to it, and cause its rapid development. The work of the Montana parties will be about the head waters of the Missouri River, where the floods originate which cause so much damage along the lower Mississippi; and in addition to mapping the country and noting its topography, etc., they will make a special examination of the watershed, to determine where dams can be built to hold back the destructive floods. Attention will also be given to the use of the water thus stored in irrigation. All triangulation upon the Pacific coast has to be completed early in July, before the summer haze sets in. This strange phenomenon has never been satisfactorily explained. It seems to be a mixture of smoke and dust, filling all the valleys, and rising thousands of feet into the air. It obstructs the view so that no point over five miles distant can be distinguished.

—May 1, the local committee of the American Association for the Advancement of Science, together with a number of the leading citizens of Cleveland, met in the Board of Education rooms in the Public Library Building to make arrangements for the meeting to be held in Cleveland next August. Prof. C. F. Mabery of the Case School of Applied Science took the stand as temporary chairman, and in a few preliminary remarks introduced Prof. F. W. Putnam, the permanent secretary of the association, who gave a most interesting history of the association and its objects. The officers of the local committee are: president, Cady Staley; vice-presidents, Hon. John Sherman, Hon. H. B. Payne, Pres. H. C. Haydn, Gov. J. B. Foraker, Col. John Hay, Mayor B. D. Babcock, Hon. Samuel E. Williamson, Mr. W. J. Gordon, Gen. M. D. Leggett, Mr. L. E. Holden; secretary, Elroy M. Avery, Ph.D. Committee on post-office, telegraph, and express: Prof. A. H. Tuttle, chairman; Capt. F. A. Kendall, secretary. Committee on the press: Prof. Bernadotte Perrin, chairman; Prof. A. H. Thompson, secretary. Committee on printing: C. G. Force, chairman; Dr. Elroy M. Avery, secretary. Committee on membership: Hon. C. C. Baldwin, chairman; Rev. Jabez Hall, secretary. Committee on invitations, receptions, and excursions: Mr. W. R. Warner, chairman; Newton M. Anderson, secretary. Finance committee: Mr. Solon Severance, chairman; Mr. Charles A. Post, secretary. Committee on rooms: Prof. Edward W. Morley, chairman; Prof. Herbert C. Foote, secretary. Committee on hotels and lodgings: Mr. Edward H. Fitch, chairman; Mr. Harry P. Cushing, secretary. Committee on transportation: A. J. Smith, chairman; Elroy M. Avery, secretary.

—The Texas State Geological and Scientific Association, which has for a number of years endeavored to arouse a general interest in the geological exploration of Texas, has memorialized the State Legislature, asking that it be made the agent of the State for carrying on geological work, and that a director be appointed to supervise such work. The ground which the association takes is so clear and reasonable, that it must recommend itself to the legislators. It is proposed to explore principally the deposits of minerals of economic value, and thus to give the citizens of the State that knowledge of the real value of the land they hold which they

lack at present, and at the same time to develop the resources of the country. In order to make the work of such a survey as useful as possible, it is proposed to make the results known through the agency of the daily press and other publications, to be issued as rapidly as possible. It is to be hoped that the practical and wise measures proposed by the association will be carried out, as they cannot fail to benefit the people of the State.

LETTERS TO THE EDITOR.

* * * Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.

Twenty copies of the number containing his communication will be furnished free to any correspondent on request.

The editor will be glad to publish any queries consonant with the character of the journal.

Is the Rainfall increasing on the Plains?

IN view of the recent discussion on this subject which has appeared in this periodical, perhaps it will not be amiss to add a few remarks to those of Mr. Curtis concerning the errors which may arise in climatic studies from errors in rainfall records. Rainfall records have probably been kept as long in New England as in any other part of the United States, and a number of them give indications of a secular change in the amount of rainfall. But Mr. E. B. Weston, Desmond Fitzgerald, and others who have had occasion to study some of these records, state that in certain cases the apparent change in the amount of rainfall was clearly due to the different methods pursued by different observers in measuring snow, and converting it to its equivalent in rain; and they think but little reliance can be put in the results obtained from a comparison of earlier with more recent records. Mr. Weston has also shown that gauges with different kinds of rims give persistently different results. If these early volunteer records are of uncertain value for studying climatic changes, are those which are now being gathered by our national Signal Service to prove more so? These latter records are in almost every case obtained from rain-gauges exposed on the roofs of houses; and hence the amount of rain caught becomes a function of the wind-velocity, a function of the wind-direction, and a function of other variants and variables, not least among which is a not uncommon change in the position of the gauge itself. Numerous experimental observations have shown that gauges exposed on roofs catch more rain when exposed on the side opposite to the direction from which the wind blows, and less rain when exposed on the same side from which the wind blows. The writer thought that the large errors which may arise from this source were fully recognized by the Signal Service officers and by the scientific public, so that it was unnecessary to call attention to them. But recently he has listened to two papers by well-known writers, dealing with changes in the amount of rain, especially in the West; and both these writers referred to the valuable records now being obtained by the Signal Service as furnishing a basis for future studies of this kind. The present writer inferred from these papers that the errors arising from exposure are not so fully known as they ought to be, and hence presents a brief study of the Boston rainfall record, which is only one of several similar cases which have come under his notice. For several years in succession the annual rainfall at the Boston Signal Service station has been reported below the normal. According to the Bulletin of the New England Meteorological Society, in 1885 it was nearly three inches below the normal, in 1886 nearly five inches, and in 1887 nearly thirteen inches below. This seemed rather strange, since none of the numerous gauges around Boston showed such marked deficiencies. Thus, in 1887, when the Boston Signal Service station reported the annual rainfall thirteen inches below normal, the Harvard College Observatory, only three miles west of Boston, reported an annual rainfall twelve inches greater than that reported from Boston, and one inch greater than the average of twenty years' observations at the observatory. The observer at Lynn, Mass., ten miles north of Boston, reported an annual rainfall fifteen inches greater than Boston, and six inches above the average of thirteen years' observations at Lynn. According to the records of several gauges in Milton, ten miles south of Boston, the annual rainfall was from nine to twelve inches greater than at the Boston station. These stations are all so close to

Boston, that it is rendered entirely improbable that there was in reality any great deficiency in the Boston rainfall; and the apparent deficiency seems clearly due to a change in the position of the Boston gauge about 1883 or 1884. Previous to this the gauge had been exposed on the roof of the Equitable Building in Boston, and these records were used in forming a series of averages or normals. Then the gauge was removed to a high tower on the Post-Office Building, and since then there has been almost a persistent deficiency of precipitation as compared with former records, or with the records of stations surrounding Boston. Moreover, the amount of rainfall caught is evidently a function of the wind-velocity, and decreases with increased velocity of the wind. Thus, during a gale on April 2, 1887, the amount of precipitation reported from the Boston Signal Service station was 0.22 of an inch; while measurements by a number of observers in and around Boston showed that snow fell to a depth of over a foot, and when melted gave an inch of precipitation as ordinarily recorded. Again, during the storm of March 11 to 14, 1888, the Boston Signal Office reported 1.24 inches of precipitation, while surrounding stations reported three inches or more.

It seems a pity that our Signal Service gauges should be so badly exposed, for these are looked to as the standards throughout the country; and there is no doubt that in the future, as in the past, there will be attempts to prove climatic changes from their records; but the writer feels that any one who has had experience with rainfall observations will look dubiously on any conclusions based on such records as exist at present.

H. HELM CLAYTON.

Blue Hill Observatory, May 2.

Significance of Sex.

SOME recent publications on the subject of the significance of sexual reproduction, especially those of Dr. Weissmann (*Nature*, xxxiv. p. 629, 1886, and xxxvi. p. 607, 1887) and a short abstract of a lecture by Hatschek (*Annals and Magazine of Natural History*, i. p. 163, 1888), have induced me to draw brief attention to some speculations of my own on this subject, published several years ago.

1. Dr. Weissmann, in his admirable paper on the significance of polar globules (*Nature*, xxxvi. p. 607, 1887), after showing that there must be some very great benefits resulting from the introduction of sexual reproduction, says, "Such beneficial results will be found in the fact that sexual propagation may be regarded as *the source of individual variability, furnishing material for natural selection.*" Now, in an article on genesis of sex, published in the *Popular Science Monthly*, December, 1879 (xvi. p. 167), and republished in the *Revue Scientifique* for Feb. 14, 1880 (xviii. p. 220), the same thought is distinctly implied, though not distinctly expressed. The whole contention of the article is to show that the object of sex is the funding of individual differences in a common offspring, thereby improving the offspring; and, further, to show how much pains nature has taken to make individual sexual differences greater and greater in the history of evolution. In the last paragraph I say, "Such mixing produces more *plastic nature*, more generalized, and therefore more progressive form."

This was written nearly nine years ago. Meanwhile the thought continued to develop in my mind. In a book ('*Evolution and its Relation to Religious Thought*') just now published, but most of which, and especially all on this subject, was written three years ago, the same thought is much more distinctly expressed. On p. 220 I say, "Why was sex introduced at all? There are doubtless sufficient reasons of many kinds, but the *fundamental reason connected with evolution is the funding of individual differences in a common offspring, thereby giving to the offspring a tendency to divergent variation.*" Again on p. 223: "*Complexity of inheritance, like complexity of composition in chemical substances, gives instability to the embryo and liability to variation to the offspring; and this in its turn furnishes material for selection of the fittest.*" This was written in the fall of 1884; but, being much pressed with other work at that time, I laid aside the manuscript, and only took it up again, finished it, and sent it to the publisher, about a year ago. I do not bring this forward now by way of reclamation, — for even if I had any right to make such, which I have not, I care little who brings out a truth, — but partly because I would not seem to borrow an

idea without due credit, and partly because I am gratified that a thought which has lain long in my mind is now confirmed by so eminent a biologist and so profound a thinker as Dr. Weissmann.

2. There is one point, however, in Dr. Weissmann's paper, to which I would take some slight exception. He says, "There is *no essential, but only individual differences* between the nuclear substance of the spermatozoön and of the ovum. There are *no such things as male and female nuclear substances*, but only male and female cells, carriers of immortal germ plasm." Now, if by 'essential differences' he means mysterious or occult differences, such as are usually attributed to sex, he is probably right; but surely sexual reproduction is a device of nature whereby greater individual differences of nuclear substances are produced than could have been gotten in any other way. Such extreme individual differences are called 'sexual' in the case of organisms: why not also in the case of nuclear substances?

3. In the other paper referred to, Hatschek, after criticising the views of Weissmann and others, goes on to give his own theoretical opinion; viz., "that in sexual reproduction we must recognize a remedy against the action of *injurious variability*." He then goes on to show that disease or injurious variation of any kind in an individual would be indefinitely continued by non-sexual modes of reproduction, but in sexual reproduction is quickly eliminated by crossing with other strong and healthy individuals. Now, precisely this view is very distinctly brought out in my article on genesis of sex. Referring to the reasons for the introduction of sexual reproduction, I say (p. 177), "The reason is probably this: *Among all the qualities, good and bad, strong and weak, inherited (by the offspring) from both sides, there is a sort of struggle for life, and a survival of the best and strongest qualities*." The same thought is expressed in many ways in my book on evolution, already referred to.

JOSEPH LECONTE.

Berkeley, Cal., April 24.

Catching Fixed Forms of Animal Life on Transparent Media for Study.

IN studying forms of animal life that become fixed to foreign bodies during their early stages of development, it is an obvious advantage to the investigator if they can be induced to attach themselves to transparent media, such as glass or mica, so that they may be studied without disturbance under the microscope with transmitted light.

Several attempts have been made to secure young oysters on glass by Prof. John A. Ryder,¹ Dr. R. Horst,² and Lieut. Francis C. Winslow,³ but with only very partial success. Professor Ryder once found larvæ attached to the glass sides of an apparatus in which artificial propagation was being carried on. Dr. R. Horst tried ground and plain glass, but secured only two on the latter. Prof. Karl Möbius, in the *Zoologischer Anzeiger* of Jan. 22, 1883, describes a successful attempt to catch fixed organisms on glass. He used microscope-slides, and secured annelids, hydroids, polyps, *Bryozoa*, *Infusoria*, diatoms, etc. Prof. B. H. Van Vleck informs me that he habitually secures fixed forms of low organisms on glass microscope-slides for study.

During the summer of 1887, I was studying the development of the oyster (*O. virginiana* Lister) at Buzzard's Bay; and as I was anxious, if possible, to get them growing on glass, I tried several methods to accomplish the desired end. During my work I had very valuable assistance and suggestions from Dr. E. B. Larchar of Onset, whose disinterested aid I here acknowledge.

In a small pond-like estuary, bare at low tide, on the 14th of July, I stretched wire netting between stakes driven into the sand and raised about a foot from the sand. On this were laid panes of glass, fastened in place with clothespins. Other panes were suspended from the sides, some in the plane of motion of the incoming tide, others opposed to it. Lamp-chimneys were also suspended from the apparatus. I used some fifty panes and twelve chimneys,

¹ J. A. Ryder, On the Mode of Fixation of the Fry of the Oyster (Bull. U.S. Fish Com., ii. 1882); An Account of Experiments in Oyster-Culture, and Observations relating Thereto (Rep. U.S. Fish Com., 1882), Washington, 1884.

² R. Horst, On the Development of the Oyster, *O. edulis* L. (Rep. U.S. Fish Com., 1884), Washington, 1886.

³ F. C. Winslow, Notes upon Oyster Experiments in 1883 (Bull. U.S. Fish Com., iv. 1884).

but met with almost total failure, securing only two oysters, one of which, however, grew to twenty-one millimetres in diameter. A few barnacles became attached to the glass.

One of the most successful spatting-grounds for oysters at Buzzard's Bay is a sand-spit exposed about four hours at low water. Here the incoming tide divides, one branch flowing to Onset, and the other to Buttermilk Bay. The force of the current is very great. On this bar, at the suggestion of Dr. Larchar, earthenware drain-pipes were partially sunk in an upright position, and loosely filled with broken glass. Six-inch and four-inch pipes were used, and at different elevations above the sand. I did not secure any spat in the four-inch pipes. A six-inch pipe sunk nearly to the level of the bar was successful, but in an unlucky day was filled up with sand, and the young oysters buried. Six-inch pipes, reaching about ten inches above the bar, were the most successful, and on the glass in them I got large numbers of young oysters. Suitable conditions for the success of the undertaking were therefore as follows: (1) a strong tide-way, which would bring plenty of free-swimming fry, and afterwards abundant food for their maintenance; (2) an area of quiet water within the pipe, in which the fry could settle and attach themselves to the smooth glass; (3) the absolute shutting-out of violent currents which would detach them from their precarious abiding-places.

I first found spat on the glass on the 25th of July, and on the 28th took out a pane 6 by 4½ inches square, on which I have just counted eighty-two young oysters, as it is still in my possession intact. This was only exceptional in the size of the glass, as other pieces bore nearly or quite as many spat proportionally to their area. Spat were secured in the pipes until the 29th of October, when few were left, large numbers having dropped off by the natural dissolving action of sea-water upon the organic cement by which they are attached.

Besides oysters, *Anomias*, *Crepidulas*, and *Bryozoa* freely attached themselves to the glass, presenting admirable opportunities for studying them alive and undisturbed.

The nature of my researches required that I should get young oysters with shells as clean and perfectly preserved as possible. In May, year-old oysters were found very beautifully preserved on the inside whorls of a dead *Busyon* shell, where they were completely protected from all eroding action, and clean. To imitate these conditions, in the salt-pond above referred to, I suspended a large number of two-and-a-half and three inch flower-pots inverted, from galvanized wire stretched between stakes driven firmly into the sand. The pots were raised about six inches from the sand. They met with entire success. The pots in many instances were literally almost covered with spat. On the outside of the pots very little, and on the inside no, sediment was deposited, as the pots hung like suspended bell-jars, so that the oysters were perfectly clean and very finely preserved. Further, on account of the porosity of the earthenware, the oysters had less hold than on natural cultch of stones and shells, and were easily removed for study.

ROBERT T. JACKSON.

Cambridge, Mass., May 4.

Answers.

31. BLONDE AND BRUNETTE. — A week or two ago a correspondent of yours complained of the lack of precision of meaning attached to the terms 'blonde' and 'brunette,' and the want also of words treating of intermediate shades of color as applied to the hair and complexion of Caucasian human beings. There is certainly a need of more convention on this point; for it seems strange that lower animals, and even inanimate objects (*vide* dry-goods, etc.), should be minutely characterized as regards color, whilst their lords or makers are not. It would seem as if a century and a half ago there was such better understanding about terms of color as this gentleman wishes to see established. In the *Spectator* one meets with proof of this. In one place I remember a lady (assumed) writer draws the distinction between herself and a friend in the matter of complexion as between an olive and a brunette; and the term 'a handsome black man' (to imply the latter hue in a man) is also met with in the writings of the last century.

ALFRED J. HILL.

St. Paul, Minn., May 3.